Bridging the Math-Physics Gap: Strengthening STEM Readiness with PUM and ISLE

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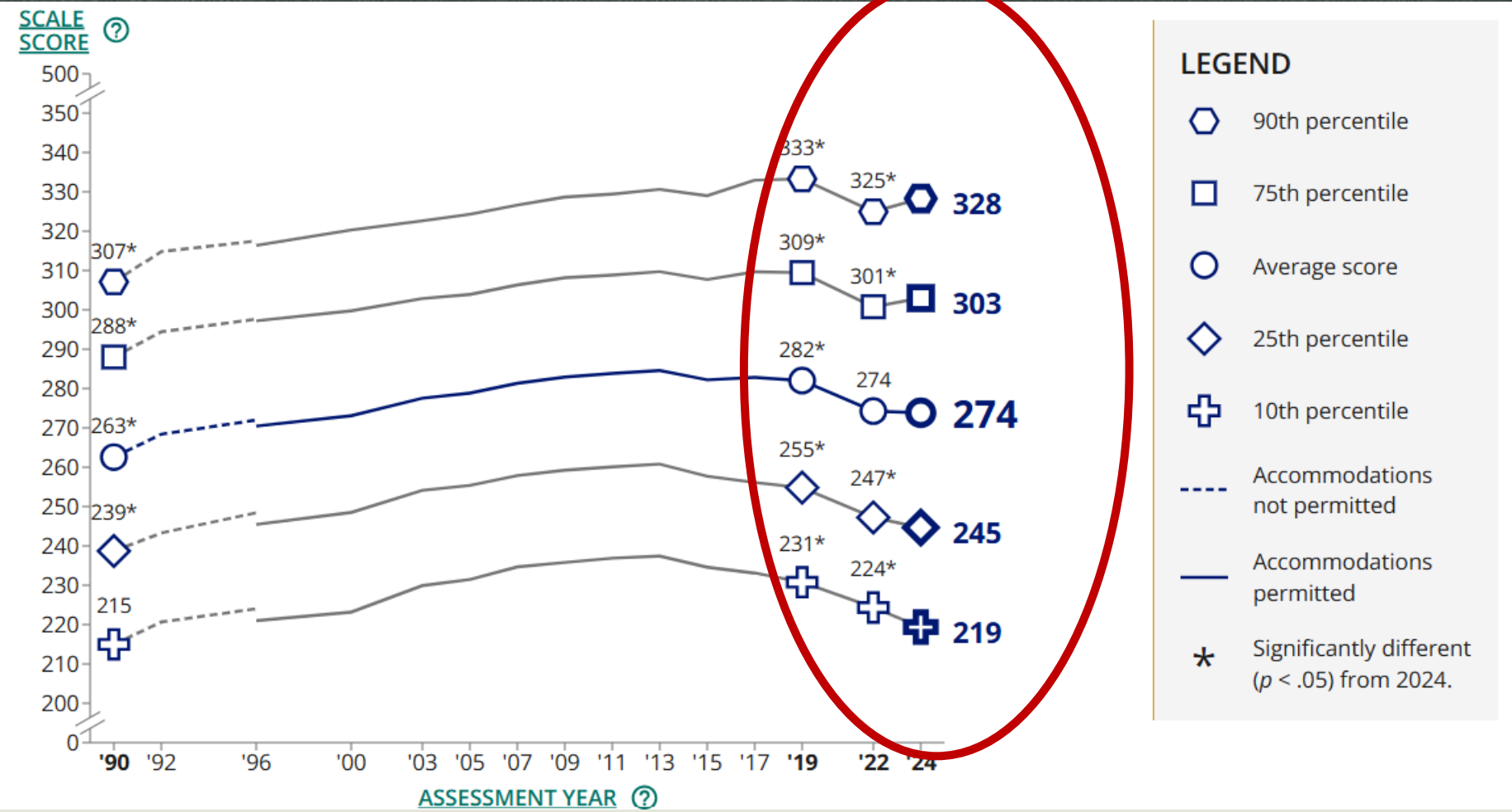
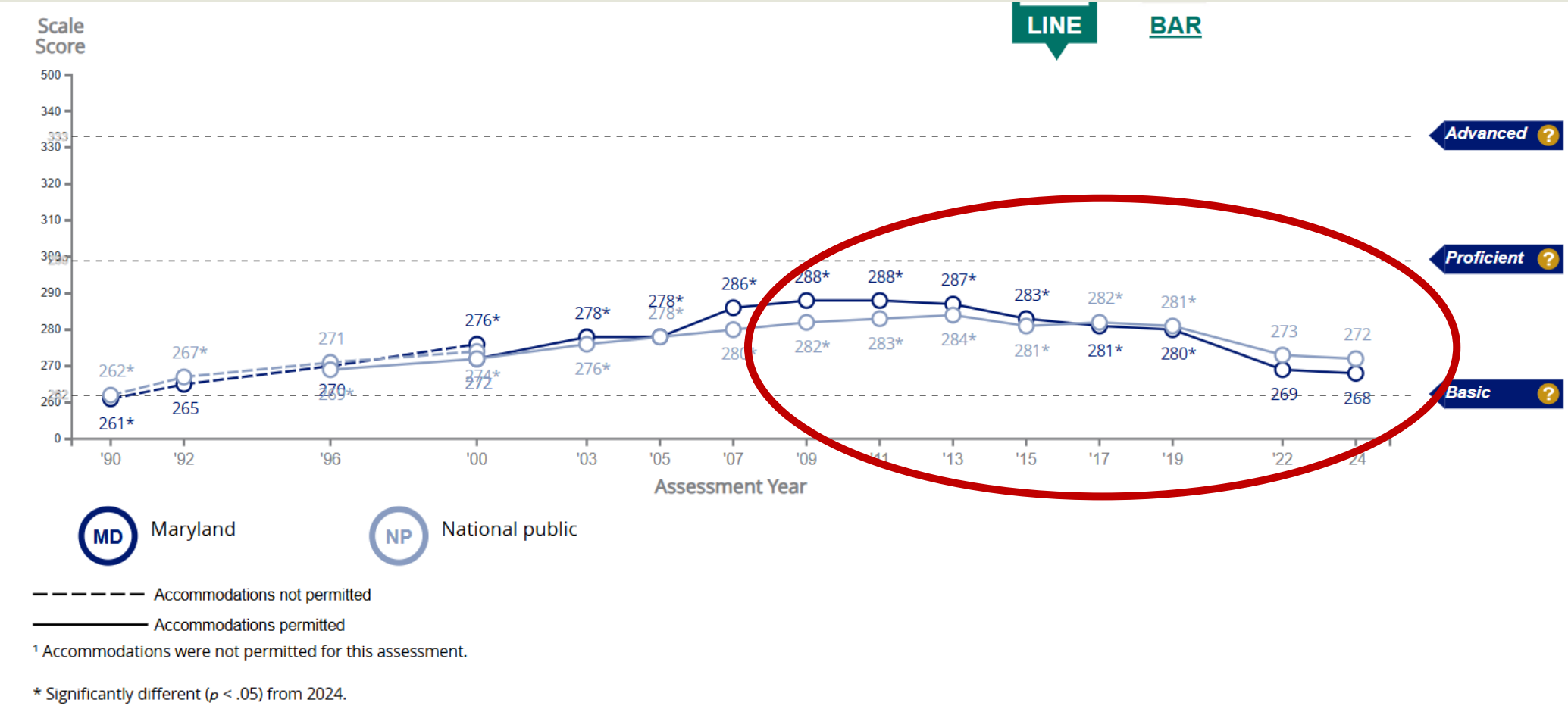
The Nation's Report Card: 8th grade Mathematics



Source: https://www.nationsreportcard.gov/reports/mathematics/2024/g4_8/?grade=8

The Nation's Report Card: Mathematics in Maryland



Source: https://www.nationsreportcard.gov/profiles/stateprofile/overview/MD?sfj=NP&chort=2&sub=MAT&sj=MD&st=MN&year=2024R3&cti=PgTab_OT

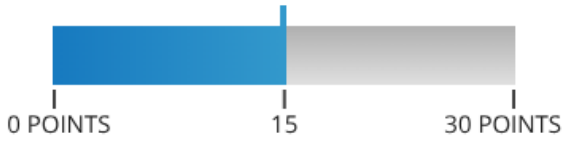
Academic achievement school report card show underperforming Mathematics versus English Language Arts

ACADEMIC ACHIEVEMENT

HOW DID STUDENTS PERFORM ON STATE TESTS?

The academic achievement indicator is a combination of the percent of students scoring "proficient" or higher on state tests in math and English language arts, and the average performance level of students on state tests.

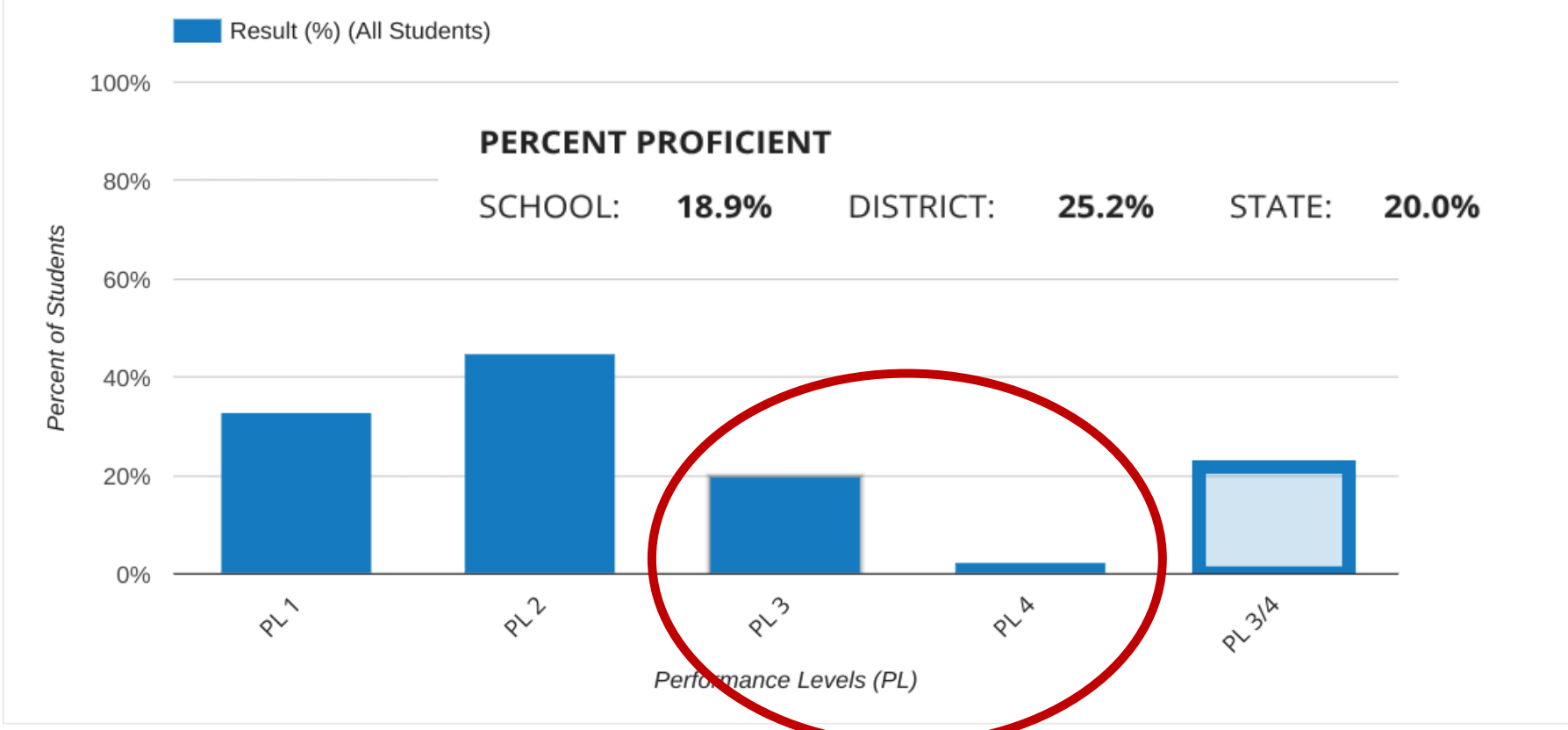
15.1
EARNED POINTS
(TOTAL POINTS POSSIBLE: 30)



MEASURE	RESULTS	EARNED POINTS*
Percent Proficient Mathematics	22.1%	1.7 out of 7.5
Percent Proficient English Language Arts	61.7%	4.6 out of 7.5
Average Performance Level Mathematics	1.9	3.6 out of 7.5
Average Performance Level English Language Arts	2.7	5.2 out of 7.5
		15.1 EARNED POINTS

Source: https://reportcard.msde.maryland.gov/Graphs/#/ReportCards/DetailsIndex/1/H/1/21/0305/2023

Mathematics Proficiency lower than district and state

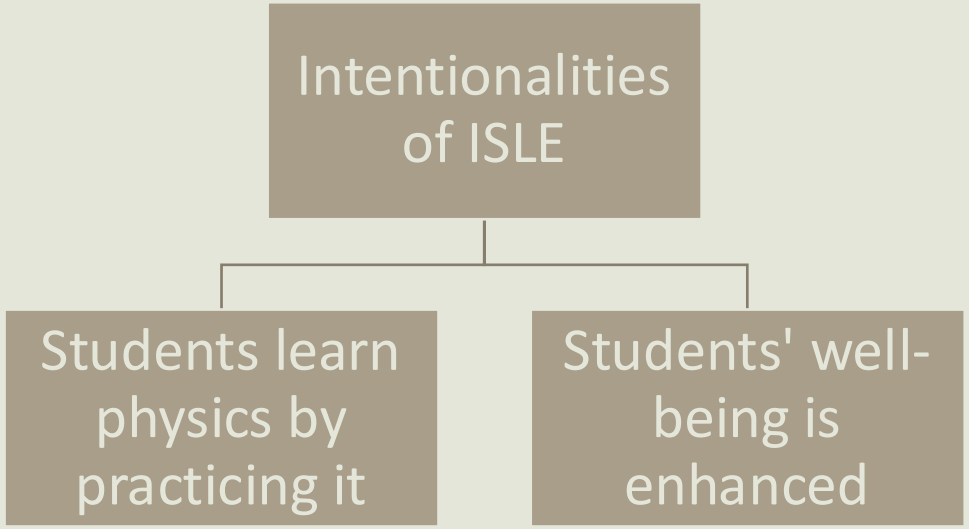


Filter Results:

Year: 2024, *Assessment Types*: Math - Geometry, *Gender*: All Students, *Special Services*: All Students, *Race and Ethnicity*: All Students

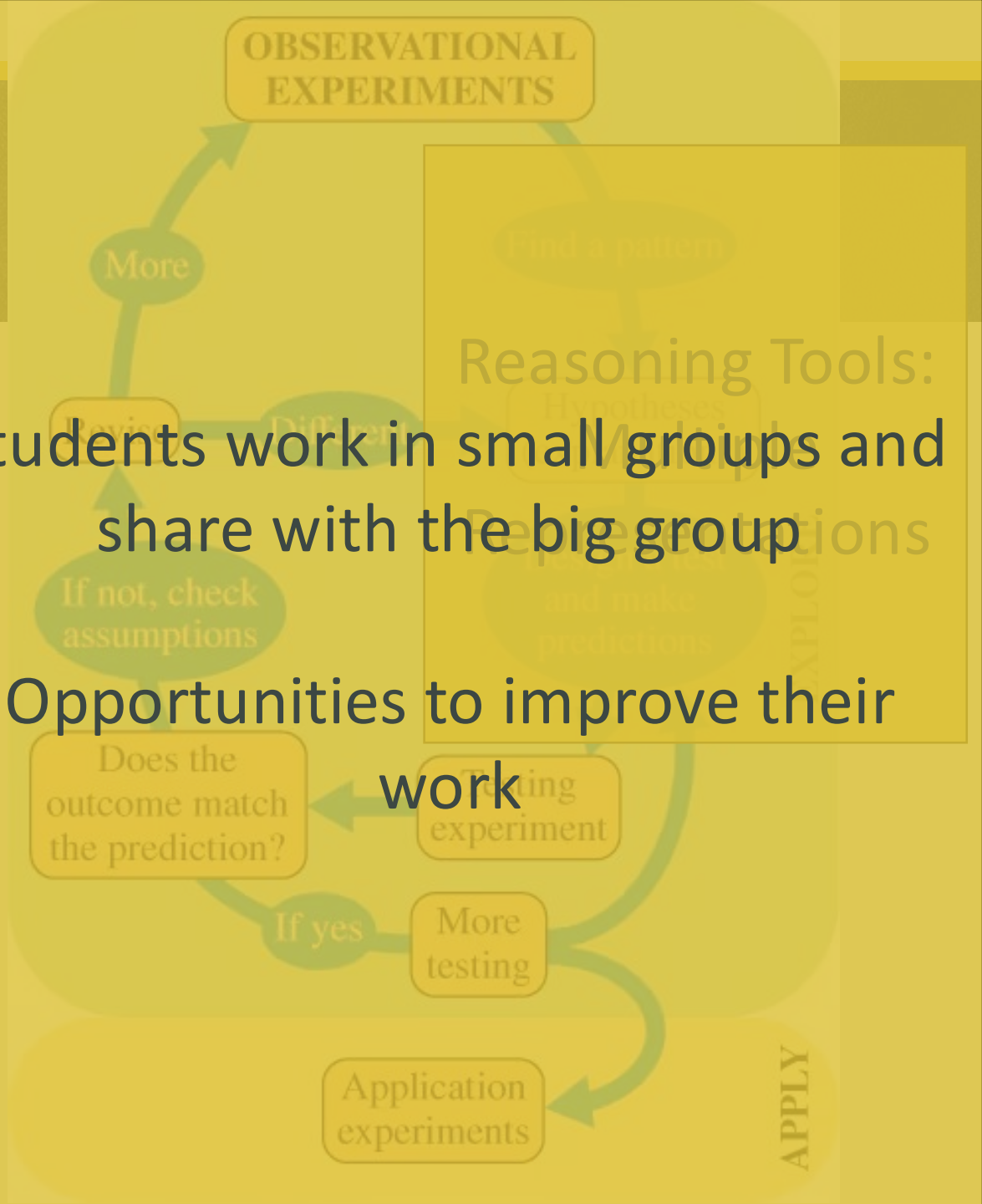
Source: https://reportcard.msde.maryland.gov/Graphs/#/Assessments/MathPerformance/UALG01/U/6/3/1/21/0305/2024

Investigative Science Learning Environment - ISLE



Students work in small groups and share with the big group

Opportunities to improve their work



Source: Etkina, E., Planinsic, G., & Van Heuvelen, A. (2021). College physics: Explore and apply (2nd ed.). Pearson; http://pum.islephysics.net/; https://doi.org/10.1103/PhysRevPhysEducRes.16.020148;

Curriculum and Implementation at-a-glance

Plan

Honors Physics at Career Technology High School

Physics Union Mathematics (PUM) curriculum based on ISLE Methodology

PUM: Kinematics & Dynamics in 2.5Marking Periods + 13 Quizzes + 2 Tests with self-assessments

IIHS: Momentum, Energy in 0.5 Marking Period + 2 Projects + 1 Report

Pivot Interactives: DC Circuits, Waves and Optics

No homework

Source: https://pum.islephysics.net/details.php

Kinematics and Dynamics are great lessons to review math concepts

PUM Kinematics lessons

- Motion is Relative
- Which way is which?
- Constructing Dot Diagrams
- Graphing and Physical Quantities
- The Truth behind graphic representations
- Find where and when would we meet
- Inventing and Index
- Using slopes and making functions of lines
- How fast do you walk?
- When worlds collide!
- Motion Diagram: A new tool
- Time for stretching
- Average speed
- When speed is not constant
- Putting it all together

Source: https://pum.islephysics.net/details.php

PUM Dynamics lesson

- Forces as Interactions
- Can a table push?
- Combining Math and Physics
- Motion Diagrams and Force Diagram
- Newton's Second Law Qualitatively
- Newton's Second Law Quantitatively
- Forces exerted by Earth on objects
- Newton's Third Law
- Friction
- Practice for Test
- Review and Summary

Teaching multiple representations: words, sketches, diagrams, tables, graphs and functions to represent motion

HP-1.8a: How Fast Do You Walk?

8.1 Represent and Reason

Since there is a relationship between position, time, and velocity any two of the values to de third. The table above shov 5 different objects.

Object #	Velocity v	Time interval Δt	Change in position Δx
1	15 m/s	2 s	30 m
2	2 m/s	0.5 s	1 m

8.2 Represent and Reason

The following function describes the motion of a biker: $x(t) = 3\text{ m} + (-5\text{ m/s})\,t$

a) Explain what each number in the equation means.

b) What is the independent and dependent variables in the function?

c) Where is the object at $t = 0$? Where is the object at $t = 3$ seconds?

d) How far has the object travelled in 3 seconds?

Source: https://pum.islephysics.net/details.php

3 minutes of Questions & Answers

Plan
Evaluate Implement

Acknowledgements

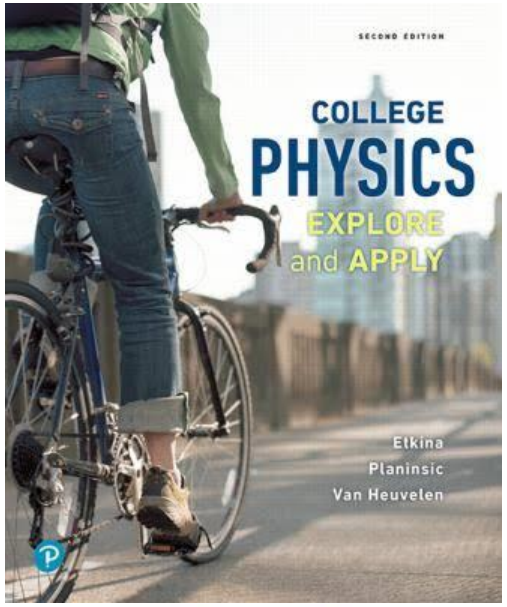
450 students

BOYD J. MICHAEL III TECHNICAL HIGH SCHOOL

WCPS
Washington County Public Schools

CSAAPT

pivot interactives



PUM

Takeaways

- Use the scientific process as a way to learn and teach
- Teach Physics and Math simultaneously
- Both Kinematics and Dynamics unit work on multiple representations skills: words, graphs, tables, functions for position, velocity, acceleration and force.
- ISLE / PUM activities keep students engaged

References

- Etkina, E. (2015). *Millikan award lecture: Students of physics—Listeners, observers, or collaborative participants in physics scientific practices? American Journal of Physics, 83*(8), 669–679. https://doi.org/10.1119/1.4923432
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